Washington State
Department of Transportation

Urban Areas Congestion Analysis - March 2006

The urban and near-urban areas of Washington have grown rapidly in recent decades. Evidence—new houses and shopping areas—is everywhere. The number of jobs has increased, too. With the growth has come ever-increasing traffic on freeways and highways, where peak-period demand has outgrown the capacity of transportation systems. Two million more people are expected to be added to the state's population by 2025, and most of them are also expected to locate in the state's urban and near-urban areas. How can investments in transportation systems and facilities best offset the substantial further increases in congestion and delays that are expected to accompany this growth?

What the Legislature Asked Us to Do

"The study must include proposals to alleviate congestion consistent with population and land use expectations under the growth management act, and must include measurement of all modes of transportation."

- ESHB 1163 Sec. 222 (1)

What Scenarios Were Studied?

There are several approaches to addressing roadway congestion. One approach that almost everyone agrees on is to improve the operations of roadways so that their inherent capacity is more effectively used. This approach is familiar in Washington State where many specific strategies have been pioneered. More needs to be done and is being done.

This study, however, does not specifically model and address the transportation congestion improvements that can be gained from more emphasis in this area. The study, through computer modeling, looked at several other strategies: expanding highways and transit systems; augmenting system investments to reshape transportation demand; and changing policy to value price roadways.

Why study congestion?

In 2003, the Washington State Legislature requested that the Washington State Department of Transportation (WSDOT) study congestion in the form of delay both now and in the future in our state's major urban areas. The study's purpose was to help understand, using computer forecasting tools now used by regional planners, how various ways of approaching transportation investment might help to offset the coming increases in congestion and delay. Policy-makers and citizens can include the results of the analysis in their thinking on how to address the ever-increasing and very costly problem of the imbalance between peak-period demand and peak-period capacity in our transportation systems, especially our freeways and highways serving the urbanized areas.

Three separate but coordinated studies were conducted for the Central Puget Sound, Vancouver and Spokane regions. For each region a travel-demand model was used to forecast future travel patterns in order to assess what congestion might look like in the year 2025. Projected travel demand in each region was based on regionally adopted growth plans and forecasts of population and employment. A series of new transportation scenarios was then analyzed, using a computer model, to project how traffic congestion could be reduced. The new scenarios focused on utilizing highway investments, transit investments, value pricing or combinations of the three. Finally, a benefit/cost assessment was conducted on the scenarios.

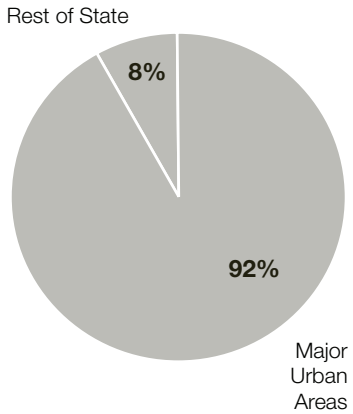
In broad terms, the analysis will provide some answers to:

- What is the existing performance of our transportation system?
- How much will our urban areas grow in population and employment over the next 20 years based on current growth expectations and growth management?
- What does this growth mean for future demand on our transportation system?
- What are some of the investment options and how does a computer model suggest they would meet particular levels of congestion relief?
- What are the costs and benefits of these options?

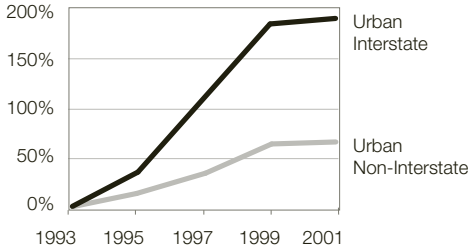
What is the level of traffic congestion in urban areas today?

From 1980 to 2003, Washington's population grew by 45 percent, the number of vehicles increased by 77 percent, and the number of workers grew by 55 percent. Vehicle-miles traveled nearly doubled, up over 90 percent, while the number of lane-miles increased by only 8 percent. This growth was concentrated almost entirely in and near the state's urban areas. As a result, congestion and resulting delays grew on many important highways, especially in the state's most urbanized areas, Central Puget Sound, Vancouver and Spokane.

Total Hours of Delay in Washington State (2001)



Growth in Daily Hours of Delay in the State's Major Urban Areas



How can we fight back against the increases in delay and congestion?

The challenge for our state's urban areas is to devise remedies for the growing pressure—and the accompanying rise in congestion and delay—that growth places on urban transportation facilities. This is especially true for major highways and freeways whose capacity, at least during peak periods, has already been reached and surpassed.

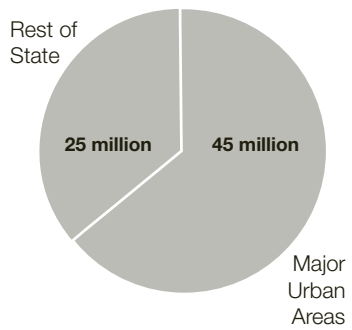
There are essentially two choices:

- Invest in expansion of roads and/or transit systems to meet the growing demand as predicted by computer models.
- Charge tolls for the use of highway systems ("pricing") to alter travel demand and spread the use of the system away from congested periods and into uncongested periods.

A range of investment scenarios was analyzed. The range included a current baseline for 2025 containing projects that were fully funded prior to approval by the state Legislature of the 2005 Transportation Funding Package; scenarios that would focus new investment exclusively on roadways, transit, or pricing; and mixed scenarios that include investments in more than one type of capacity improvement.

An analytical computer model was then used to test how each of these scenarios would perform against future congestion levels using a number of measurements.

Total Expected Increase in Daily Vehicle Miles Traveled 2003-2005



How the Travel Forecast Model Works

Planners use computerized travel demand forecast models to predict future travel conditions and congestion levels. The travel patterns are based on what levels of growth will occur and where jobs and housing will be located. The model uses a series of steps to get forecast results:

1. Trip generation forecasts the number of trips that will be made;
2. Trip distribution determines where the trips will go;
3. Mode choice predicts how the trips will be served by the available modes of travel; and
4. Trip assignment predicts the routes that the trips will take, resulting in traffic forecasts for the highway system and ridership forecasts for the transit system.

Key Themes from Urban Areas Congestion Analysis

The following summary highlights key themes that emerged from all three areas studied in the Urban Areas Congestion Analysis ––Puget Sound, Vancouver and Spokane. Region specific results are contained in subsequent chapters.

Can we reduce congestion with only major highway improvements?

Highway expansion was analyzed in the three urban areas by testing, through computer modeling, how varying levels of freeway and arterial expansion would affect future congestion levels.

For example, in the Central Puget Sound region, the most expansive highway scenario added about 1,230 more freeway and 730 more arterial lane miles to the baseline for 2025. In the Spokane region, the most expansive highway scenario added 137 more freeway and 382 more arterial lane miles to the baseline. In the Vancouver region, 100 more freeway miles and 186 more arterial miles were added to the baseline.

Key elements of the forecasts from the computer model include:

- Roadway improvements could effectively reduce congestion; travel times for the corridors with significant capacity additions would be greatly improved, some would be better than today.
- However, if people continue to travel as they do today and if all the projected future population and job growth materializes, they could overwhelm the most extensive capacity expansion scenarios tested in this study.
- Due to man-made and natural environmental constraints, reducing total regional delays in 2025 to below today's levels through highway improvements alone would be very expensive.

Can we help offset increases in congestion with only significant transit improvements?

A very aggressive expansion of transit infrastructure and services was modeled to test its effect on future level of congestion. For example in the Puget Sound area, transit service was quadrupled compared with existing conditions; over 200 miles of high-capacity transit facilities were added, including regional light rail and an extended monorail system above levels envisioned in the now-defunct plan of the Seattle Monorail Project. In the Vancouver region, bus service was increased 150 percent compared with existing conditions. This would include 21 miles of high-capacity transit facilities such as regional light rail.

Key elements of the forecasts from the computer model include:

- Major transit investments provide travelers with useful options to congested driving conditions;
- Transit is most effective when serving congested corridors with high density land uses and large employment centers during peak commuting periods; but
- Transit investments will have little impact on traffic congestion across the three regions as a sole solution.

Can we help offset increases in congestion with mixes of highway and transit investments?

The computer model was also used to test the congestion relief effects of three scenarios that blended highway and transit investments. Scenarios tested a mix of highway and transit investments, including combining a range of high and low levels of both highway and transit investment.

Key elements of the forecasts from the computer model include:

- Combining roadway and transit improvements to match the unique characteristics of particular corridors provides the potential for more practical congestion relief when compared to single strategies.
- Mixed investment strategies would be most practical in urban core areas where capacity investment costs are high and congestion is persistent for much of the day.

Can we help offset increases in congestion by placing a price -tolls- on highway use that vary up and down by time of day depending on levels of congestion?

The computer forecasting model was used to test a pricing scenario in which all freeways, highways and arterials in the central Puget Sound region would be subject to variable tolling. The toll would be zero when traffic demand was low and roads are uncongested, with the toll rising as demand builds to use the power of pricing to help prevent demand from exceeding capacity. At high-demand times, increasingly higher tolls would motivate people to alter their travel behavior by traveling by transit or carpool, or by changing the time of their trip. By influencing the travel of a relatively small percentage of travelers, tolls would help align demand with capacity to allow everyone to get the most out of the transportation system by lowering congestion and spreading demand.

Key elements of the forecasts from the computer model include:

- Pricing strategies are very effective in reducing delay if they use tolls that vary according to the level of congestion.
- Combining variable rate tolling for demand management with new capacity investments proved to be particularly effective in reducing delays and serving more people.
- Variable rate tolling of roadways can help to improve the efficiency of our transportation system, and may also produce revenues that can be used to improve the transportation system and how it works.

There are implications for tolling related to social equity, public perception and economic vitality that have not been analyzed.

Caution should be taken in relying on conclusions from this analysis because of challenges presented by the computer modeling and the inability to assess the cost and political acceptability of implementing the approaches.

Can we help offset increases in congestion by placing HOT lanes on the freeways?

Analyses were conducted to evaluate the effects of creating a High Occupancy Toll (HOT) lane system in the Central Puget Sound region. HOT lanes use tolls and occupancy restrictions to manage the number of vehicles traveling on them, so that vehicle volumes are always kept at the highest level that does not cause traffic to slow down, creating congestion and resulting in delays.

HOT lanes provide travelers with a choice of paying a toll to use relatively uncongested travel lanes, or incurring the time costs of congestion in the toll-free lanes.

A HOT lane network for this analysis was defined as two freeway lanes in each direction comprising an existing HOV lane and the adjacent general freeway lane.

Hot-lane key messages:

- Targeted HOT lanes not only reduce overall corridor delay, but also make the system more efficient.
- Improved reliability.
- Create a travel option for people who need a reliable trip, even if just occasionally.

What Does the Urban-Areas Congestion Analysis Tell Us?

Some areas of the state, especially the three largest urban areas, will continue to grow. In turn, without new transportation improvements, traffic congestion will become worse than experienced today. In the meantime, the cost of building transportation capacity will continue to escalate. Large-scale system-wide congestion relief through major expansion of highway and transit capacity alone is extremely expensive and very difficult to implement. However, to maintain Washington's quality of life and economic vitality, some means must be found to help serve the growing demand.

The strategic combination of highway and transit improvements with pricing appears to strike an attractive balance between adding capacity and managing demand to achieve the greatest return possible on transportation investments. This is demonstrated when value pricing is added to a mix of highway and transit capacity improvements, the computer analysis indicated a large increase in congestion reduction benefits for a small additional cost. This will be investigated further in Phase 2.

Central Puget Sound Results

This section presents the findings for the Central Puget Sound region. The study area for the Central Puget Sound region includes Snohomish, King, Pierce, and Kitsap counties.

What are the future population and employment projections for the Central Puget Sound Region?

Forecasts indicate that population and employment in the Central Puget Sound region will continue to grow. The number of households, employment, and population are forecast to increase each decade by approximately 220,000, 300,000, and 460,000, respectively.

Central Puget Sound Forecasted Growth - 2000 to 2025

1,050,000	New Residents	+ 32%
660,000	New Jobs	+ 37%
928,000	New Vehicles	+ 40%
1,058,000	New Commute Trips	+ 47%

Source: Puget Sound Regional Transportation Council

How does planning for growth lay the groundwork for transportation planning?

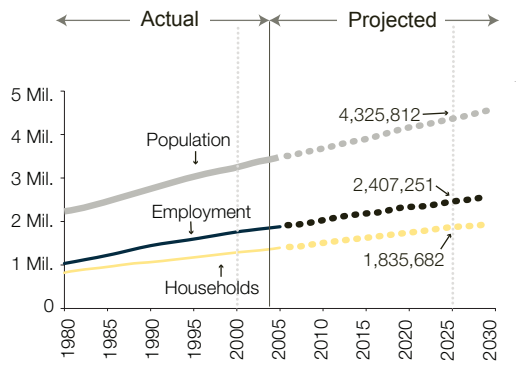
Cities and counties have prepared comprehensive plans under the state's Growth Management Act. These plans are intended to help guide the growth of housing and jobs within designated growth areas. Generally, one of the foundations of the comprehensive plans is that growth will be shaped in ways that will make transportation more efficient. In turn, the transportation system will be developed in ways that will reinforce the patterns of growth envisioned in the comprehensive plans.

Based on these expectations for growth, the Puget Sound Regional Council (PSRC) has prepared forecasts of where people will live and work in the Central Puget Sound region.

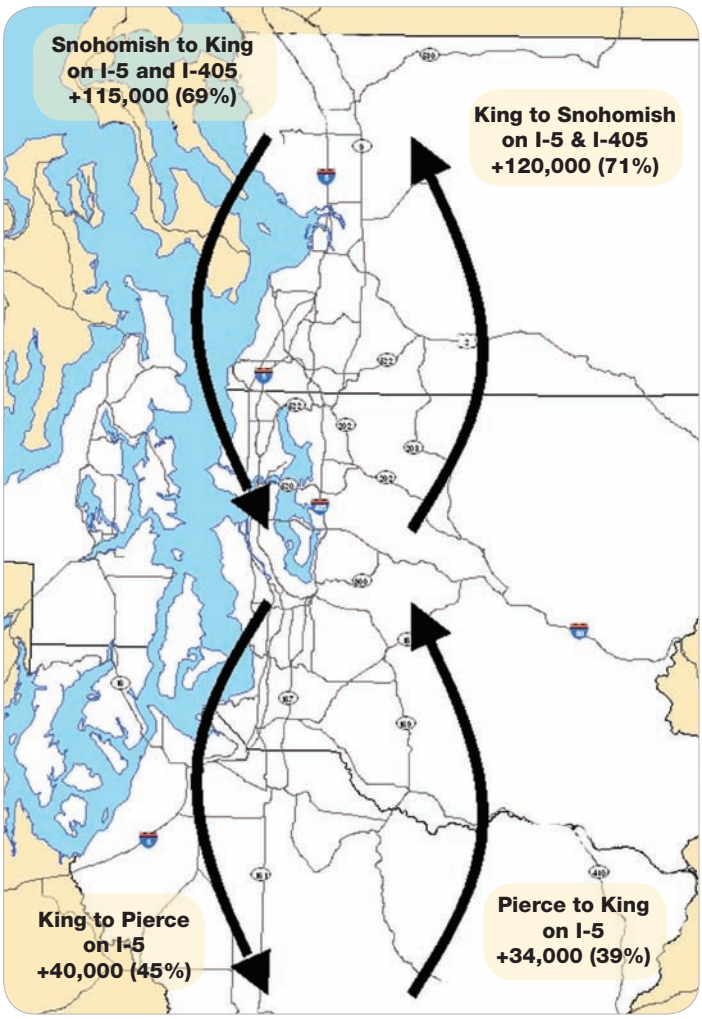
Key elements of those forecasts include:

- Strong residential growth for the year 2025 will occur outside of King County while the majority of the job growth will be in King County.
- A dramatic increase in travel demand in the Central Puget Sound region:
  - Person trips will go up 48 percent, from 12 million to 18 million per day.
  - Vehicle miles traveled will increase by 50 percent, from 73 to 110 million miles.
- An increase in the complexity of travel:
  - More suburb-to-suburb travel.
  - Travel to and from Snohomish County will increase 70 percent, East King County travel will be up by 53 percent.

Central Puget Sound Growth

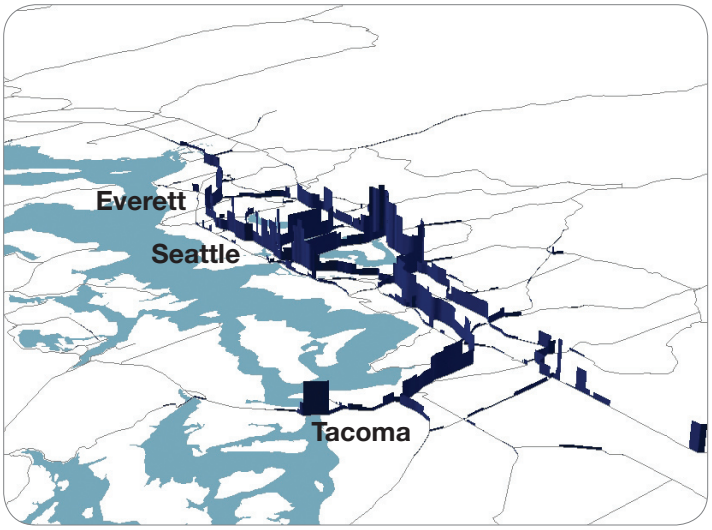


Source: Puget Sound Regional Transportation Council

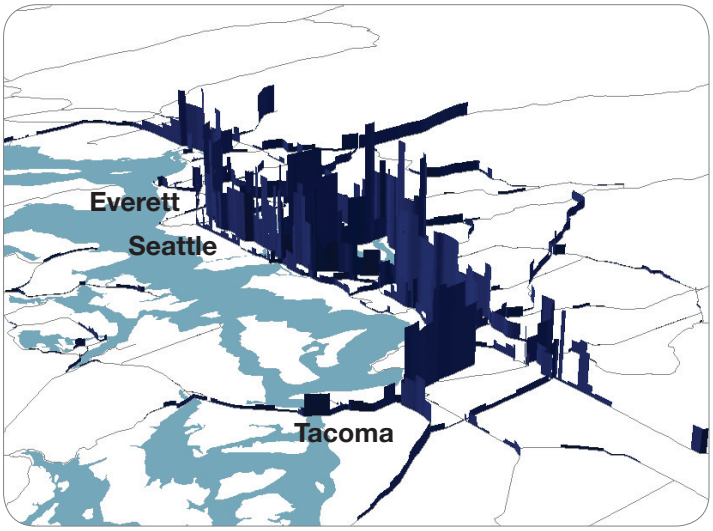


According to the computer models, how will congestion levels today compare to the 2025 baseline?

Delay Per Mile Today



Delay Per Mile 2025 Baseline



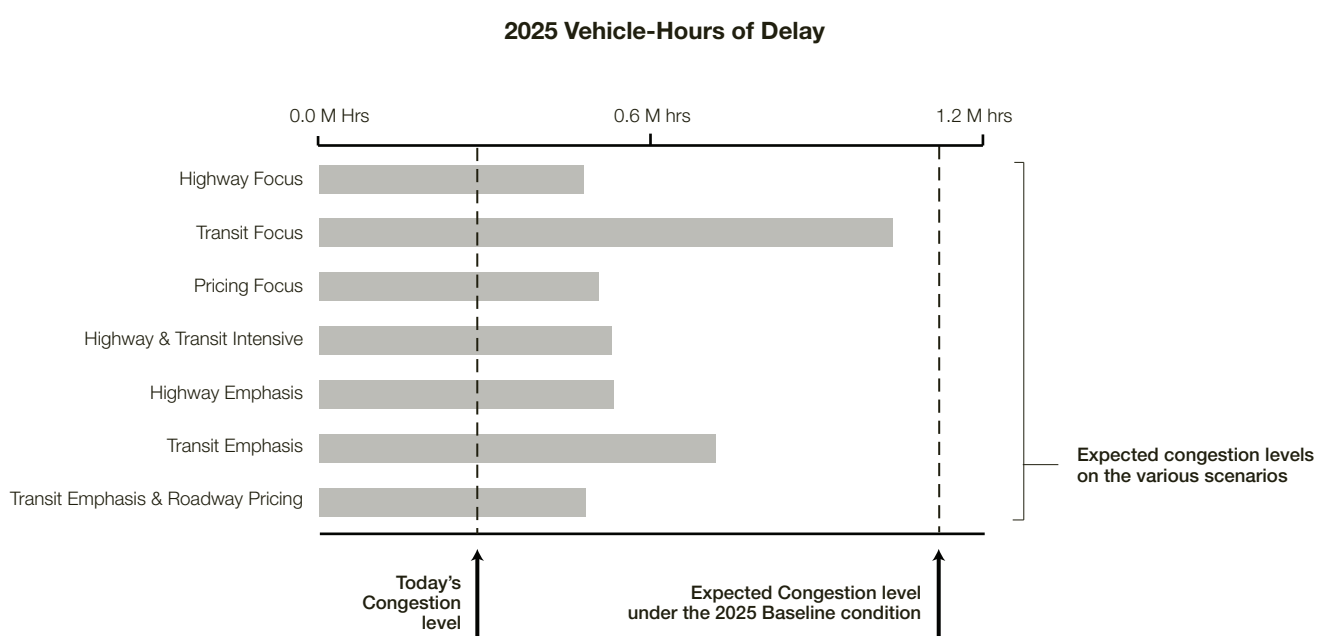
What levels of investment were studied in the scenarios?

Scenarios	Freeway Lane Miles Added+		Arterial Lane Miles Added+		Transit Service Hours Added+*		Total Capital Cost (in $ billion**)
Highway Focus	1230	52%	730	7%	0	0%	$79.1 - $104.0
Transit Focus	0	0%	0	0%	26000	104%	$24.9 - $32.8
Hwy & Transit Intensive	1010	43%	390	4%	17000	68%	$83.5 - $109.9
Hwy Emphasis	1010	43%	390	4%	12000	48%	$76.7 - $100.9
Transit Emphasis	610	26%	230	2%	17000	68%	$69.3 - $91.2
Transit Emphasis + Pricing	610	26%	230	2%	17000	68%	$69.6 - $91.7

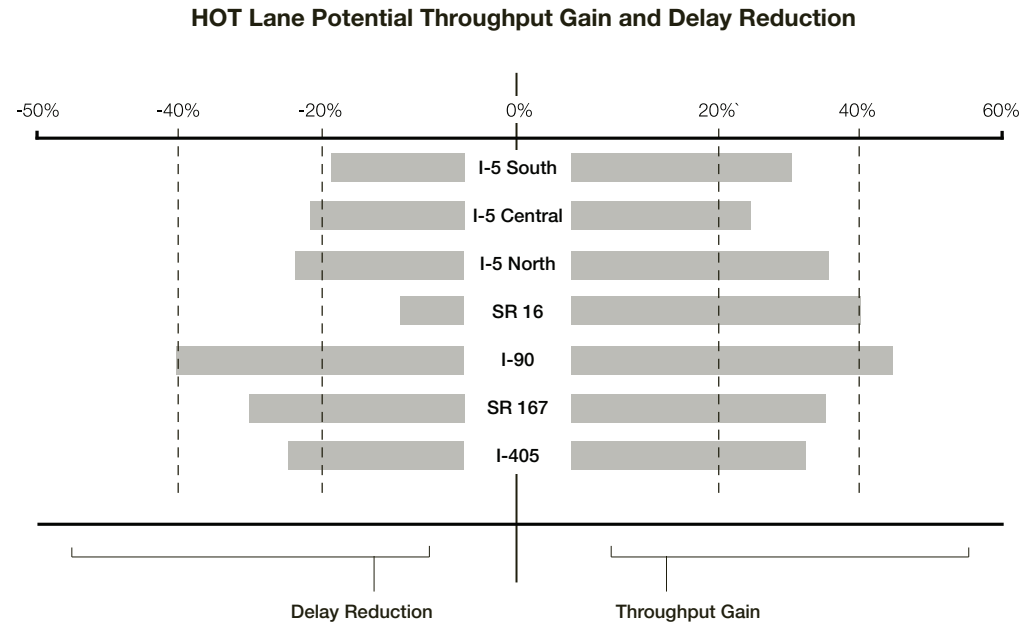
\+ Compared to 2025 Baseline
* Average weekday bus equivalent revenue hours
** Estimated 2004 dollars before present value discounting

Central Puget Sound Results

How do the scenarios compare when their forecasted results are measured against today's congestion and the baseline of expected congestion in 2025?



How could a HOT lane network, in addition to a mixed highway and transit improvement scenario, further reduce delay and improve throughput?



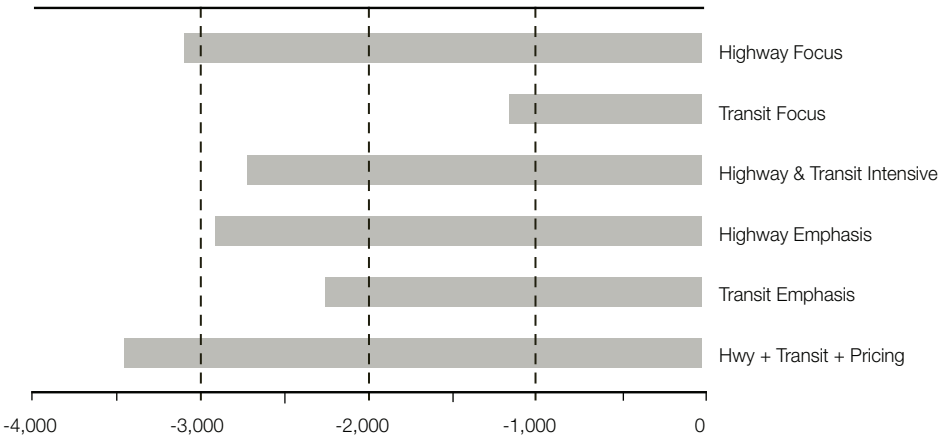
How do the scenarios compare when their forecasted results are measured against annual person-hours of delay reduction per $1 million of capital improvement from the baseline of expected annual person-hours of delay in 2025?

Adding Capacity With Targeted Investments

While extensive system-wide congestion relief is economically challenging, other work done by WSDOT indicates that targeted corridor and bottleneck investments yield benefits that exceed the cost of the projects.

For example, recently completed economic analysis of the SR 509 connection and I-405 projects indicates the estimated benefits of these projects were two to four times greater than the project costs.

Benefits in Annual Person-Hours of Delay Reduced Per Million Dollars Capital Investment



Pricing Focus Scenario (not shown) indicates much higher reductions per million dollars of investment, however significant modeling and implementation challenges exist.

Vancouver Region Results

This section presents the findings for the Vancouver Urban Area Congestion Analysis. The Vancouver study area is bounded on the north by NE 219th Street to the Columbia River on the south, on the east by the 192nd Avenue corridor and on the west by the Columbia River. Study corridors include all state highways and Interstate facilities in the study area, along with some key regional arterials. Because of the significant trip interaction between Vancouver and Portland, a portion of Portland was included in the study area: I-5 to I-205, I-84 north to the Columbia River and the I-5/I-405 loop.

What are the future population and employment projections for the Vancouver Urban Area?

Growth will continue to challenge the Vancouver/Portland region with new trips and more congestion.

According to the land use forecasts developed by Clark County and Metro and adopted regionally, employment will grow by 69 percent between 2000 and 2025.

The Vancouver Urban Area's population grew by more than 153,000 between 1980 and 2000 and is forecast to be nearly 540,000 by 2025, a growth of 63 percent from existing (2000) conditions.

Much of this growth is projected to occur in the outlying urban areas of Battle Ground, Ridgefield, La Center, Camas, and Washougal, which have little or no fixed-route transit service.

Vancouver Forecasted Growth - 2000 to 2025

208,500	New Residents	+ 63%
107,000	New Jobs	+ 69%
174,000	New Vehicles	+ 60%
209,000	New Commute Trips	+ 67%

Source: Vancouver Regional Transportation Council

How will forecast growth impact the Vancouver Urban Area over the next 25 years?

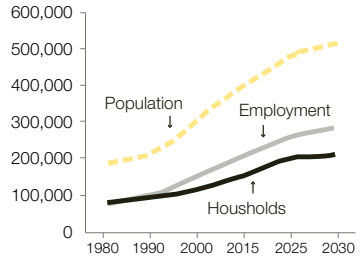
A computer model translates the forecasts of increased population and jobs for the Vancouver Urban Area into forecasts of more trips and patterns of travel. Today's gap between transportation demand and transportation capacity will grow wider.

With marked growth in households, employment, and population, travel demand will significantly increase.

Other key elements of the forecasts from the computer model include:

- Vehicle miles traveled are expected to increase by as much as 70 percent between 2000 and 2025.
- Total peak period and daily vehicle delay would increase dramatically to a level approaching 500 percent higher than today.
- By 2025, the number of vehicle trips crossing the two Columbia River bridges could increase by 50 percent.

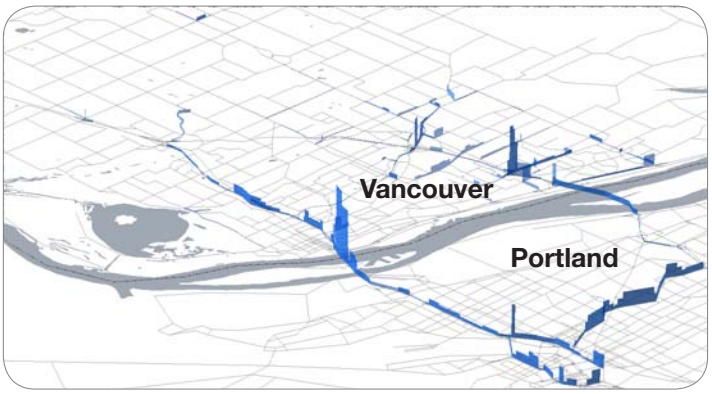
Vancouver Area Growth



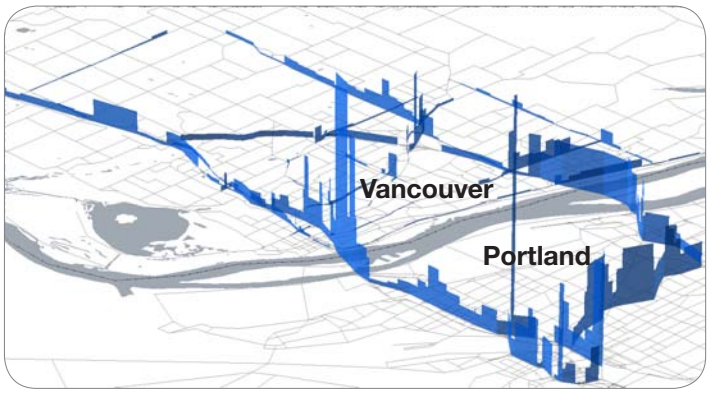
Source: Vancouver Regional Transportation Council

How will congestion levels today compare to the 2025 baseline?

Delay Per Mile Today



Delay Per Mile 2025 Baseline



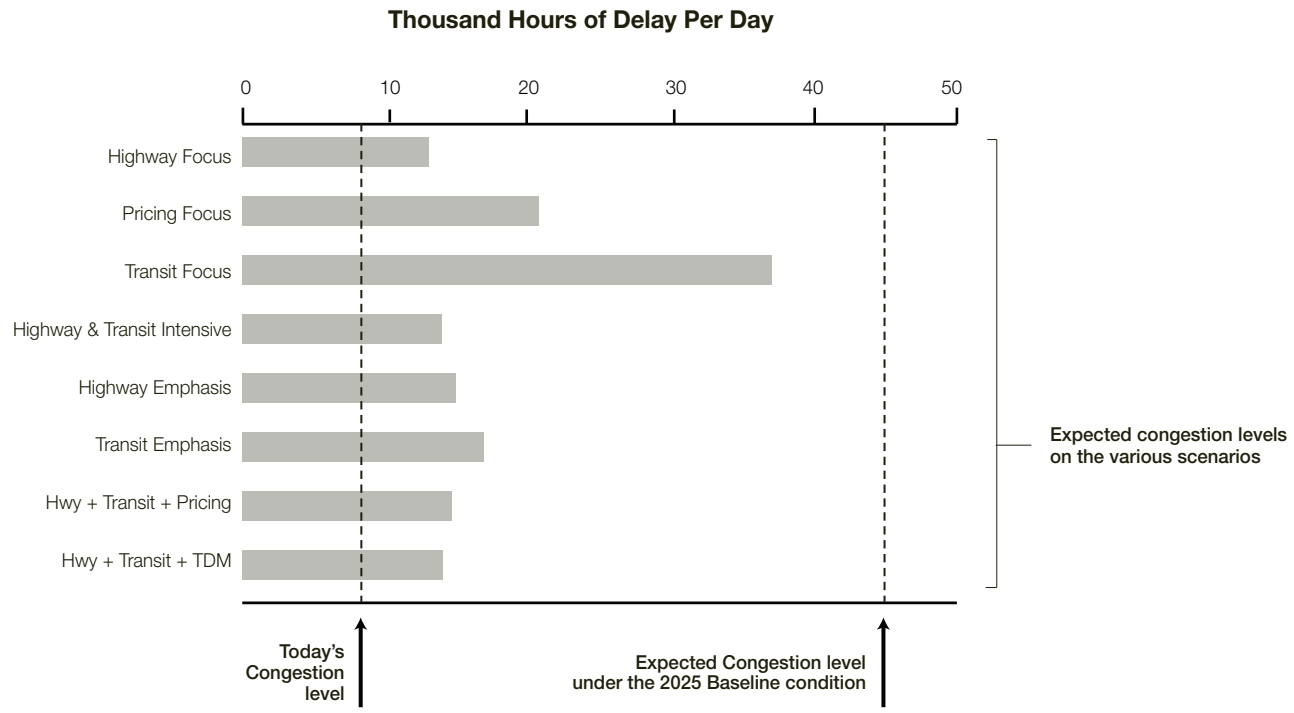
What levels of investment were studied in the scenarios?

Freeway Lane Scenarios	Freeway Lane Miles Added+		Arterial Lane Miles Added+		Transit Service Hours Added+*		Total Capital Cost (in $ billion**)
Highway Focus	101	45%	186	25%	0	0%	$3.2 - $4.1
Transit Focus	0	0%	0	0%	1338	147%	$1.9 - $2.5
Hwy & Transit Intensive	76	34%	58	8%	988	108%	$4.0 - $5.2
Hwy Emphasis	76	34%	58	8%	508	56%	$2.3 - $3.0
Transit Emphasis	36	16%	28	4%	988	108%	$3.2 - $4.2
Transit Emphasis + Pricing	36	16%	28	4%	988	108%	$3.3 - $4.3

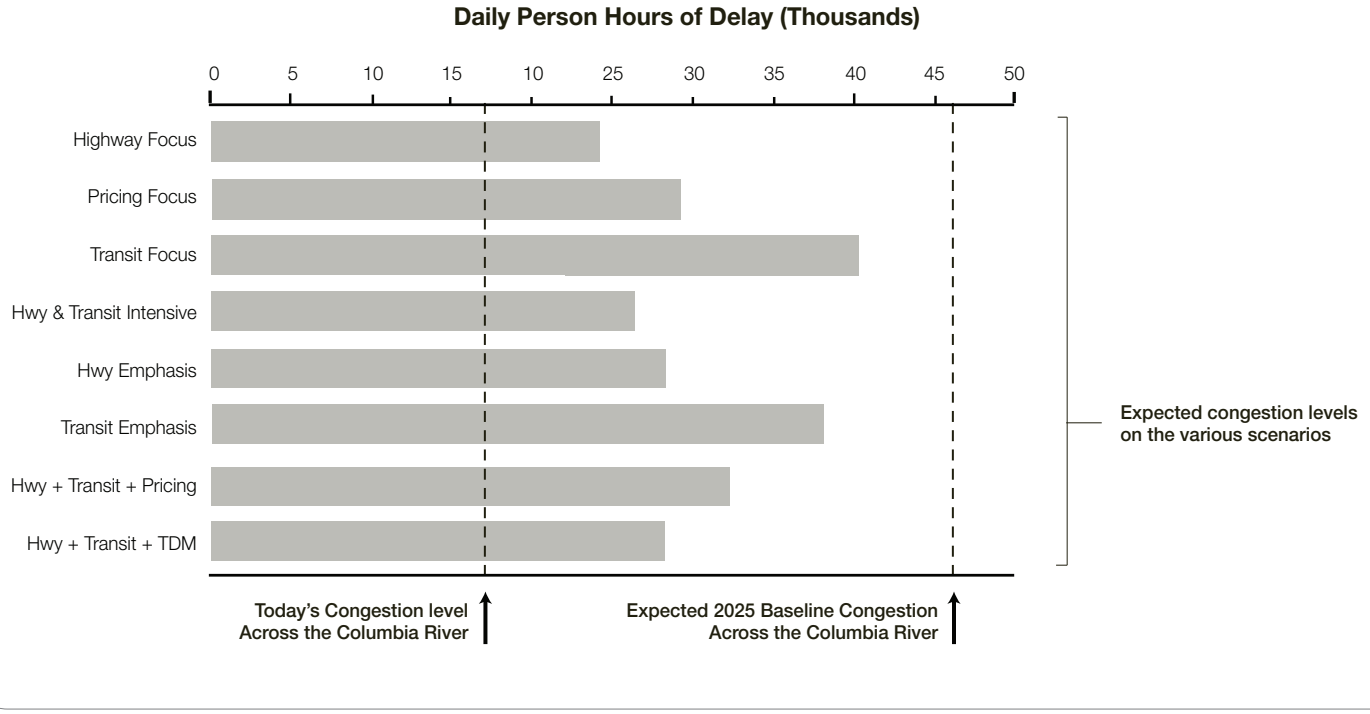
\+ Compared to 2025 Baseline
* Average weekday bus equivalent revenue hours
** Estimated 2004 dollars before present value discounting

Vancouver Region Results

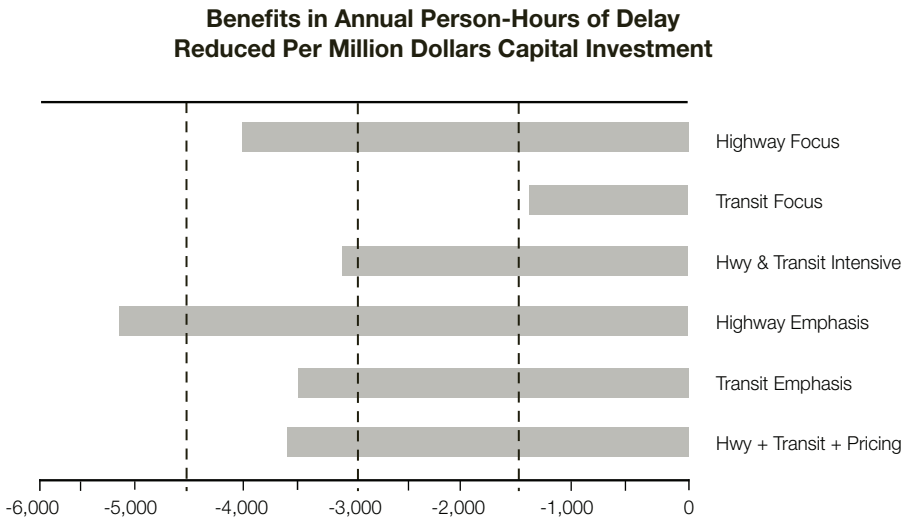
How do the scenarios compare when their forecasted results are measured against today's congestion and the baseline of expected congestion in 2025?



How do the scenarios compare when their forecasted results are measured against today's congestion and the baseline of expected congestion in the 2025 baseline at the Columbia River crossing?



How do the scenarios compare when their forecasted results are measured against annual person-hours of delay reduction per $1 million of capital improvement from the baseline of expected annual person-hours of delay in the 2025 baseline?



Spokane Region Results

This section documents the results of analyzing various congestion-relief scenarios in the Spokane area. The results provide perspectives on the degree to which congestion can reasonably be reduced in the region.

The Spokane Metropolitan Area is the largest population center in Eastern Washington and the second largest in Washington State. The area encompassed in the study includes the communities of Spokane, Spokane Valley, Liberty Lake and Millwood in addition to rural areas of Spokane County.

What are the future population and employment projections for the Spokane area?

Like the state's other metropolitan areas, the Spokane region will continue to experience growth in population, employment and new trips. Forecasts show total households in the Spokane area growing on average by 35,000 each decade. Total employment is forecast to grow on average by approximately 40,000 jobs each decade, and total population appears to grow by about 83,000 per decade.

The majority of the growth in population and employment will occur in the Spokane urban area. Areas outside of Spokane will also see a high level of growth between 2000 and 2025, with population and employment increases of over 1,000 persons/jobs in many locations.

The most pronounced growth will be in North Spokane and Spokane Valley, with many suburban areas becoming denser urban centers.

Job growth will still remain concentrated within the City of Spokane especially along US 2 (Division Street) and along the SR 290 and I-90 corridors east of downtown. Higher job growth will also be seen in concentrated pockets in sections of Spokane Valley and Liberty Lake.

Spokane Forecasted Growth - 2000 to 2025

207,000	New Residents	+ 47%
98,000	New Jobs	+ 49%
146,000	New Vehicles	+ 46%
177,000	New Commute Trips	+ 51%

Source: Spokane Regional Transportation Council

How will forecast growth impact travel in the Spokane Area over the next 25 years?

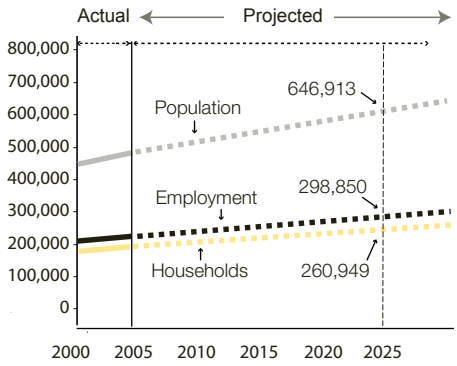
A computer model takes the forecasts of increased population and jobs for the Spokane area and translates them into forecasts of more trips and revised patterns of travel. This substantial growth in population and employment translates into significant growth in travel and congestion in the region.

The model predicts that without new transportation investment, there will be significant increases in total daily delay—a 100 percent increase from 31,000 hours of delay today to 62,000 hours of delay by 2025.

Other key elements of the forecasts from the computer model include:

- Vehicle miles traveled (VMT) are forecast to increase by approximately 30 percent to 40 percent by 2025.
- The existing road system will have 46 percent more vehicles attempting to travel on it.
- More trips being made to and from suburban communities. The roadway network in these areas should see higher demand and a greater increase in delay than what occurs today.
- Downtown Spokane will remain the region's leading destination well into the future. Growth in trips will continue to increase along corridors connecting to the downtown area.

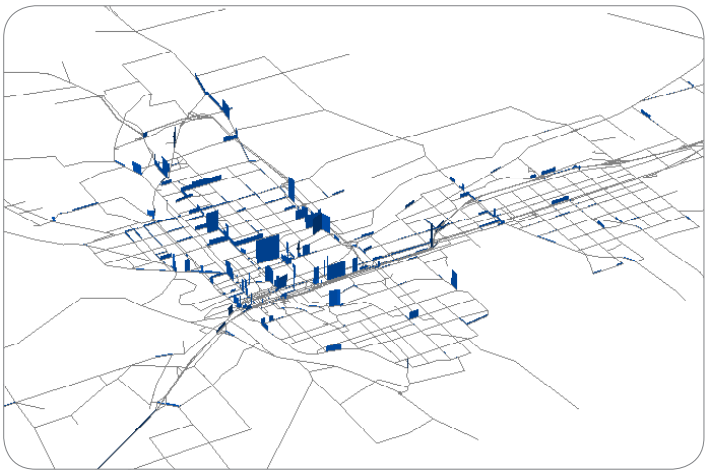
Spokane Area Growth



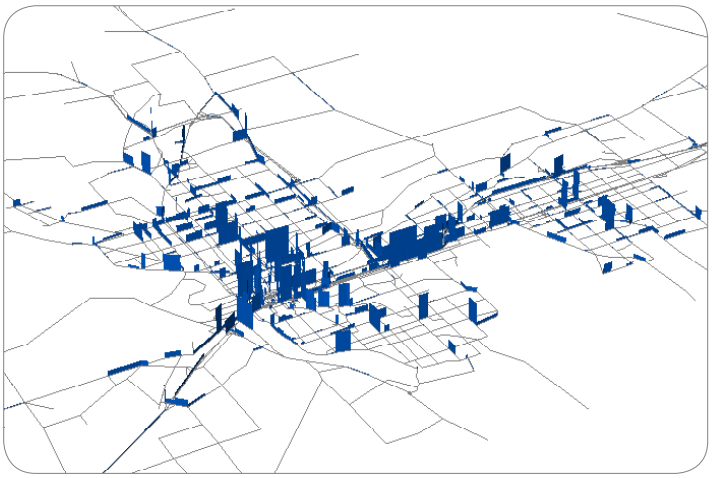
Source: Spokane Regional Transportation Council

How will congestion levels today compare to the 2025 baseline?

Delay Per Mile Today



Delay Per Mile 2025 Baseline



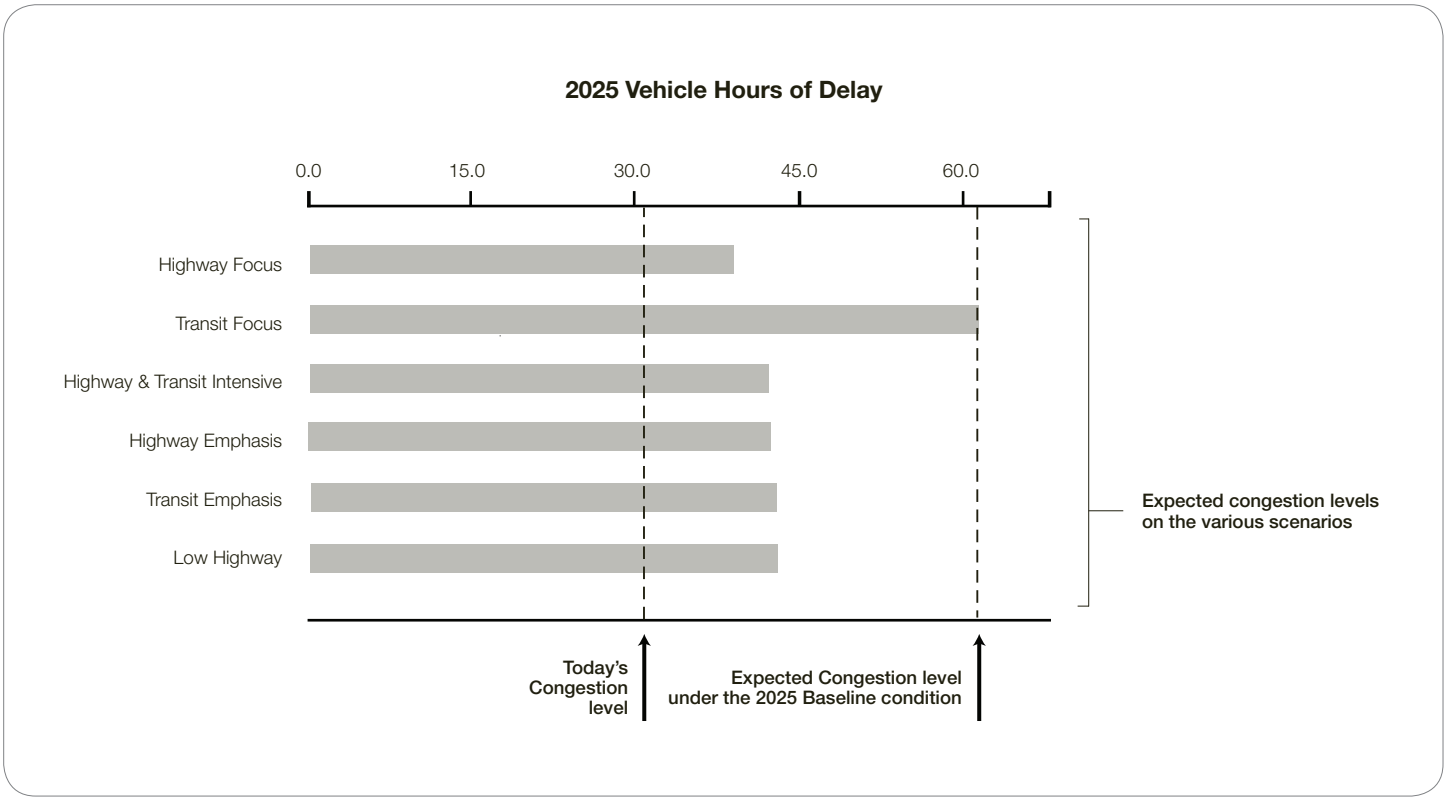
What levels of investment were studied in the scenarios?

Scenarios	Freeway Lane Miles Added+		Arterial Lane Miles Added+		Transit Service Hours Added+*		Total Capital Cost (in $billion**)
Highway Focus	137	60%	382	25%	0	0%	$6.8 - $8.9
Transit Focus	11	5%	123	8%	1812	38%	$1.3 - $1.6
Hwy & Transit Intensive	115	50%	302	20%	1812	38%	$5.3 - $6.9
Hwy Emphasis	115	50%	302	20%	0	0%	$4.7 - $6.2
Transit Emphasis	120	52%	209	14%	1812	38%	$4.7 - $6.1
Low Highway	120	52%	209	14%	0	0%	$4.1 - $5.4

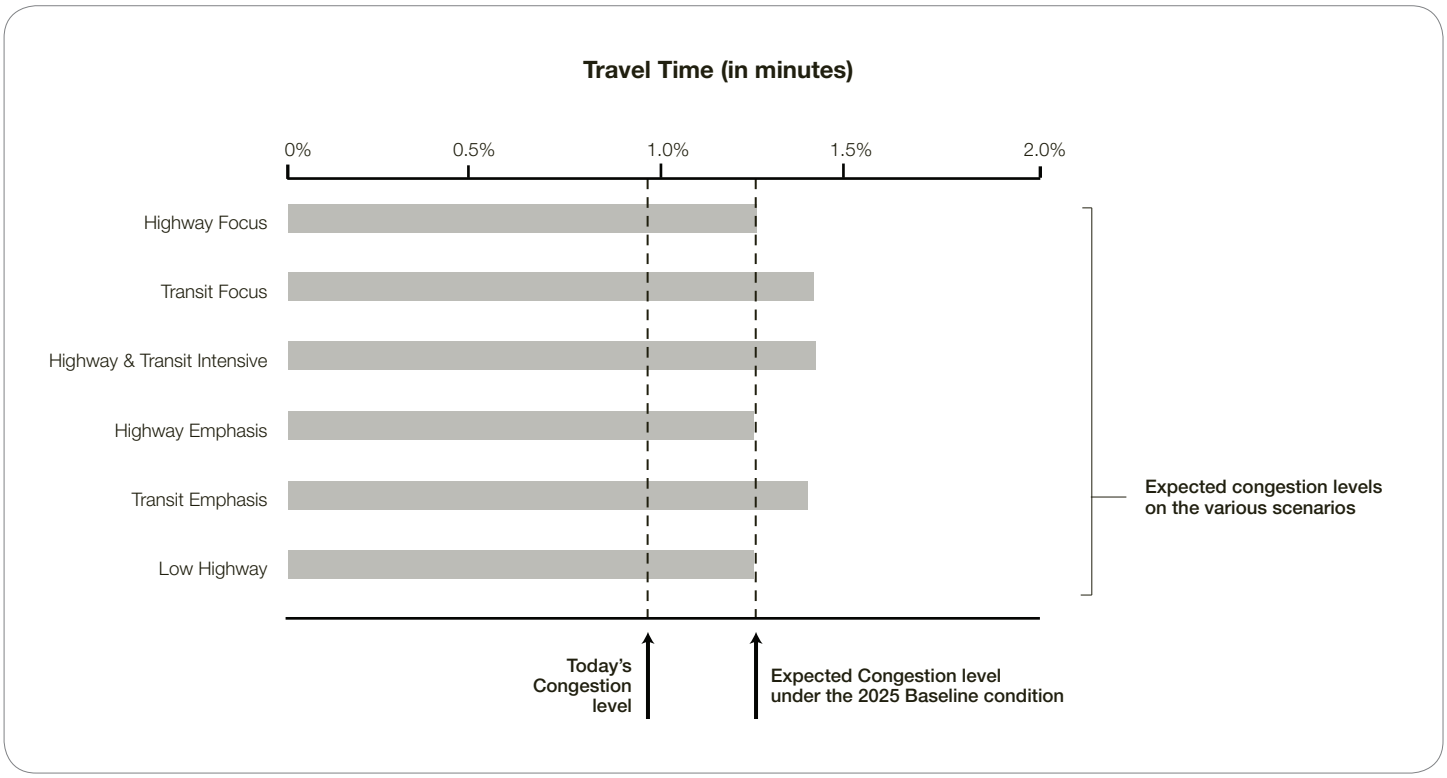
+ Compared to 2025 Baseline
* Average weekday bus equivalent revenue hours
** Estimated 2004 dollars before present value discounting

Spokane Region Results

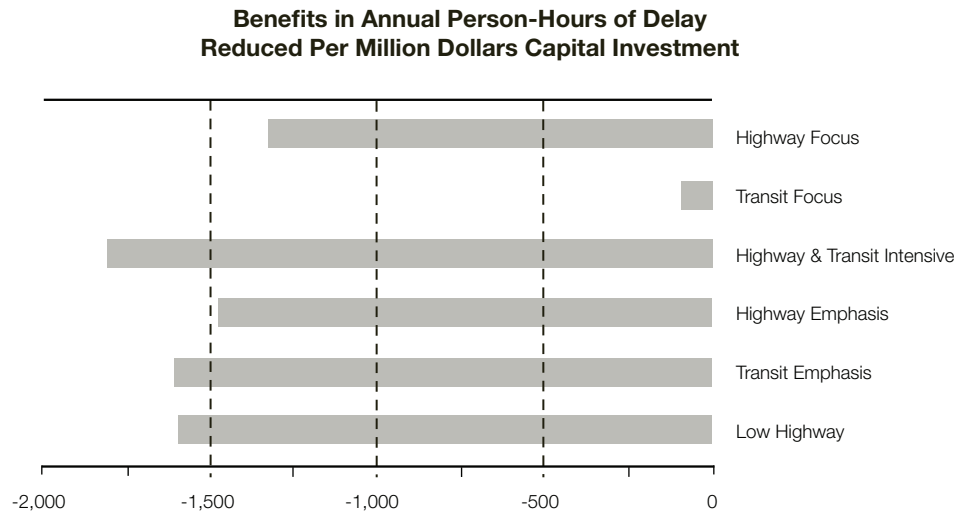
How do the scenarios compare when their forecasted results are measured against today's congestion and the baseline of expected congestion in 2025?



How do the scenarios compare when their forecasted results are measured against today's percentage of non-SOV use and the baseline of expected non-SOV use in 2025?



How do the scenarios compare when their forecasted results are measured against annual person-hours of delay reduction per $1 million of capital improvement from the baseline of expected annual person-hours of delay in 2025?



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